

Objectives

After this lesson, students will be able to

A.5.2.1 Identify the characteristics of gymnosperms.

A.5.2.2 Describe how gymnosperms reproduce.

A.5.2.3 List important products from gymnosperms.

Target Reading Skill

Previewing Visuals Explain that looking at visuals before they read helps students activate prior knowledge and predict what they are about to read.

Answers

Possible questions and answers include:

How does gymnosperm pollination occur? (Pollen is transferred from a male reproductive structure to a female reproductive structure; wind often carries pollen from male to female cones.) **How does gymnosperm fertilization occur?** (Pollen collects in a sticky substance produced by ovules. Female scales close to seal in pollen and fertilization occurs.)

All in One Teaching Resources

- [Transparency A43](#)

Preteach

Build Background Knowledge

L1

Green Trees in Winter

Ask students to name trees that stay green all winter and describe their features. (Possible answers: Fir, pine; tall with needles for leaves, cones, needle-like leaves, sticky sap)

Reading Preview

Key Concepts

- What are the characteristics of gymnosperms?
- How do gymnosperms reproduce?
- What important products come from gymnosperms?

Key Terms

- gymnosperm • cone • ovule
- pollination

Target Reading Skill

Previewing Visuals Before you read, preview Figure 11. Then write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

The Life Cycle of a Gymnosperm

Q. How does gymnosperm pollination occur?

A.

Q.

Lab
zone

Discover Activity

Are All Leaves Alike?

1. Your teacher will give you a hand lens, a ruler, and the leaves from some seed plants.
2. Using the hand lens, examine each leaf. Sketch each leaf in your notebook.
3. Measure the length and width of each leaf. Record your measurements in your notebook.



Think It Over

Classifying Divide the leaves into two groups on the basis of your observations. Explain why you grouped the leaves as you did.

Have you ever seen a tree that is wider than a car? Do trees this huge really exist? The answer is yes. Some giant sequoia trees, which grow almost exclusively in central California, are more than 10 meters wide. You can understand why giant sequoias are commonly referred to as “giants of the forest.” It takes a long time for a tree to grow so big. Scientists think that the largest giant sequoias may be about 2,000 years old. One reason they live so long is because their bark is fire resistant.

What Are Gymnosperms?

The giant sequoia trees belong to the group of seed plants known as gymnosperms. A **gymnosperm** (JIM nuh spurm) is a seed plant that produces naked seeds. The seeds of gymnosperms are referred to as “naked” because they are not enclosed by a protective fruit.

Every gymnosperm produces naked seeds. In addition, many gymnosperms have needle-like or scalelike leaves, and deep-growing root systems. Gymnosperms are the oldest type of seed plant. According to fossil evidence, gymnosperms first appeared on Earth about 360 million years ago. Fossils also indicate that there were many more species of gymnosperms on Earth in the past than there are today. Four groups of gymnosperms exist today.



For: Links on gymnosperms
Visit: www.SciLinks.org
Web Code: scn-0152

Lab
zone

Discover Activity

Skills Focus Classifying

L1

Materials hand lens; metric ruler; 2 or 3 leaves from angiosperms, such as oak tree, maple tree, day lily, and rose; 2 or 3 leaves from gymnosperms, such as pine, yew, and spruce

Time 10 minutes

Tips Encourage students to include a detailed description of the leaf's features.

Direct students to wash their hands after handling the leaves.

Expected Outcome Students will observe differences in size, length, width, and thickness.

Think It Over Groups should be needlelike shapes and broad shaped leaves. Students' reasons may include the difference in thickness and broadness of the leaves.

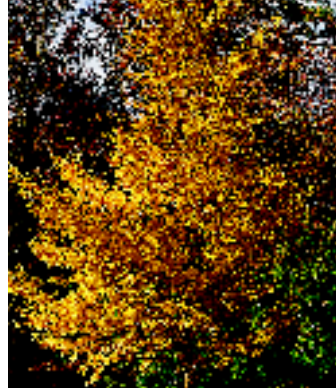
FIGURE 10

Types of Gymnosperms

Gymnosperms are the oldest seed plants. Cycads, conifers, ginkgoes, and gnetophytes are the only groups that exist today.



Gnetophyte: ▲
Welwitschia



Ginkgo: ▲
Ginkgo biloba



Cycad: ▲
Sago palm

Cycads About 175 million years ago, the majority of plants were cycads. Today, cycads (SY kadz) grow mainly in tropical and subtropical areas. Cycads look like palm trees with cones. A cycad cone can grow as large as a football.

Conifers Conifers (KAHN uh furz), or cone-bearing plants, are the largest and most diverse group of gymnosperms today. Most conifers, such as pines, sequoias, and junipers, are evergreens—plants that keep their leaves, or needles, year-round. When needles drop off, they are replaced by new ones.

Ginkgoes Ginkgoes (GING kohz) also grew hundreds of millions of years ago, but today, only one species of ginkgo, *Ginkgo biloba*, exists. It probably survived only because the Chinese and Japanese cared for it in their gardens. Today, ginkgo trees are planted along city streets because they can tolerate air pollution.

Gnetophytes Gnetophytes (NEE tuh fyts) live in hot deserts and in tropical rain forests. Some gnetophytes are trees, some are shrubs, and others are vines. The *Welwitschia* shown in Figure 10 grows in the deserts of West Africa and can live for more than 1,000 years.



What are the four types of gymnosperms?

Conifer: ▶
Giant sequoia



Instruct



For: Links on
gymnosperms
Visit: www.SciLinks.org
Web Code: scn-0152

Download a worksheet to guide students' review of gymnosperms.

What Are Gymnosperms?

Teach Key Concepts

L2

Characteristics of Gymnosperms

Focus Explain that *gymnosperm* comes from the Greek root *gymno*, meaning “naked” and *sperma*, meaning “seed.”

Teach Ask: What characteristic of a gymnosperm gives the plant its name? (*Gymnosperms have naked seeds.*) What other characteristics are common to most gymnosperms? (*Needlelike leaves and deep-growing root systems*)

Apply Ask students to infer why the conifers are the largest group of gymnosperms. (*Possible answer: They have adaptations that allow them to live in a wide variety of places. For example, many conifers can live in dry conditions because their long, thin needles limit water loss.*)

learning modality: verbal

All in One Teaching Resources

- [Guided Reading and Study Worksheet: Gymnosperms](#)



Student Edition on Audio CD

Differentiated Instruction

Special Needs

Visual Science Glossary Have students draw a characteristic of a typical gymnosperm, as well as a characteristic of each group of gymnosperms, based on the text description. Drawings should include needlelike or scalelike leaves, deep-growing root systems, and seeds that are

L1

not enclosed in a fruit. Encourage students to add a mnemonic device or memory jogger to their drawings that will help them remember the characteristic shown. (*Examples: A sewing needle for needlelike leaves, a marble for unprotected seeds, a ladder for deep-growing root systems*)

learning modality: visual

Monitor Progress

L2

Oral Presentation Have students state the characteristics common to gymnosperms.

Answers



Cycads, conifers, ginkgoes, and gnetophytes

Interpreting Data on Gymnosperms

Materials references on gymnosperms, including Web sites; state map, map pins

Time 20 minutes

Focus Challenge students to create a map showing the distribution of gymnosperms in your state.

Teach Allow students to research gymnosperms, then place pins on the map (one color for each type of gymnosperm) as they locate an area where each type grows.

Apply Ask students to explain which type of gymnosperm is most common in your state and why. (*Answers should include climate conditions in your state.*) **learning modality: visual**

Reproduction in Gymnosperms

Teach Key Concepts

L2

Pollination and Fertilization

Focus Refer students to Figure 11.

Teach Ask: **What process occurs in the male cone?** (*Male cones produce pollen.*)

What processes occur in the female cone before fertilization? (*First, an egg cell forms inside an ovule on a scale of a female cone. Next, pollination takes place on the scales. After pollen falls from a male cone onto a female cone, a sperm cell and an egg cell join in an ovule on the female cone.*) **What process follows fertilization but occurs before seeds mature and disperse?** (*The fertilized egg develops into an embryo.*) **Once the embryo develops, what else must happen for a seed to be ready to disperse?** (*The seed must mature—the seed coat and its stored food develops.*)

Apply Ask: **Is pollen more or less likely to be dispersed by wind during rainy weather?** (*Less, because the rain moistens the pollen; the pollen falls to the ground instead of being in the air.*) **learning modality: logical/mathematical**

All in One Teaching Resources

- [Transparency A44](#)

Reproduction in Gymnosperms

Most gymnosperms have reproductive structures called **cones**. Cones are covered with scales. Most gymnosperms produce two types of cones: male cones and female cones. Usually, a single plant produces both male and female cones. In some types of gymnosperms, however, individual trees produce either male cones or female cones. A few types of gymnosperms produce no cones at all.

In Figure 11, you can see the male and female cones of a Ponderosa pine. Male cones produce tiny grains of pollen—the male gametophyte. Pollen contains the cells that will later become sperm cells. Each scale on a male cone produces thousands of pollen grains.

The female gametophyte develops in structures called ovules. An **ovule** (OH vyool) is a structure that contains an egg cell. Female cones contain at least one ovule at the base of each scale. After fertilization occurs, the ovule develops into a seed.

You can follow the process of gymnosperm reproduction in Figure 11. **First, pollen falls from a male cone onto a female cone. In time, a sperm cell and an egg cell join together in an ovule on the female cone.** After fertilization occurs, the seed develops on the scale of the female cone.

Pollination The transfer of pollen from a male reproductive structure to a female reproductive structure is called **pollination**. In gymnosperms, wind often carries the pollen from the male cones to the female cones. The pollen collects in a sticky substance produced by each ovule.

Fertilization Once pollination has occurred, the ovule closes and seals in the pollen. The scales also close, and a sperm cell fertilizes an egg cell inside each ovule. The fertilized egg then develops into the embryo part of the seed.

Seed Development Female cones remain on the tree while the seeds mature. As the seeds develop, the female cone increases in size. It can take up to two years for the seeds of some gymnosperms to mature. Male cones, however, usually fall off the tree after they have shed their pollen.

Seed Dispersal When the seeds are mature, the scales open. The wind shakes the seeds out of the cone and carries them away. Only a few seeds will land in suitable places and grow into new plants.



What is pollen and where is it produced?

Lab zone Try This Activity

The Scoop on Cones

In this activity, you will observe the structure of a female cone.

1. Use a hand lens to look closely at the female cone. Gently shake the cone over a piece of white paper. Observe what happens.
2. Break off one scale from the cone. Examine its base. If the scale contains a seed, remove the seed.
3. With a hand lens, examine the seed from Step 2 or examine a seed that fell on the paper in Step 1.
4. Wash your hands.

Inferring How does the structure of the cone protect the seeds?

Lab zone Try This Activity

Skills Focus Inferring

Materials mature female pine cone, hand lens, sheet of white paper

Time 10 minutes 10 minutes

Tips **CAUTION:** Check for student allergies before this lab. Make certain that cones have some seeds inside the scales. Remind students to wash their hands afterwards.

L2

Expected Outcome The scales probably protect developing seeds from wind, rain, and very cold temperatures.

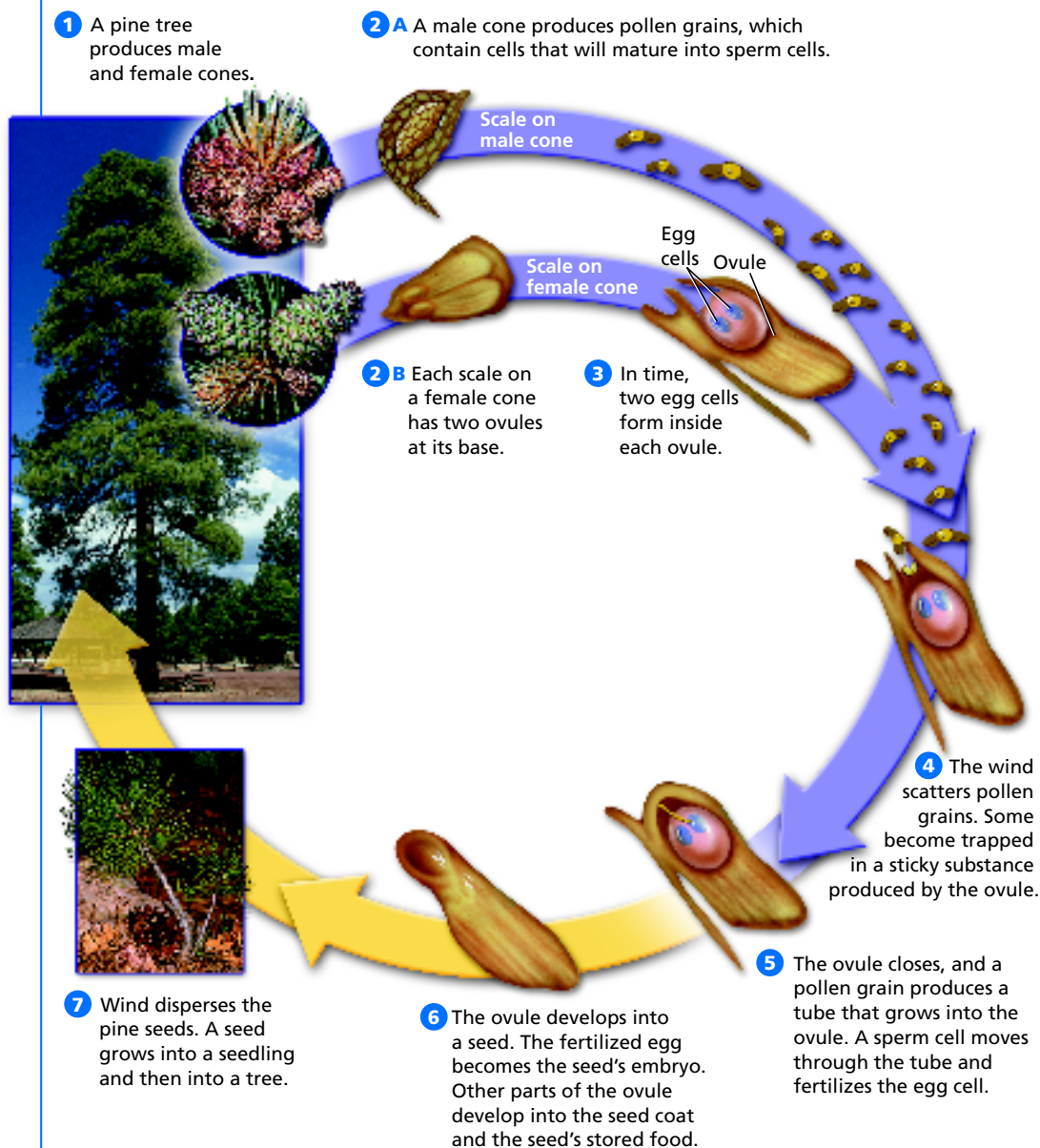
Extend Have students compare, then sketch, male and female pine cones. Sketches should indicate differences in size, shape, and structure of the scales. **learning modality: visual**

FIGURE 11

The Life Cycle of a Gymnosperm

Ponderosa pines have a typical life cycle for a gymnosperm. Follow the steps of pollination, fertilization, seed development, and dispersal in the pine tree.

Interpreting Diagrams Where do the pine seeds develop?



Help Students Read

Reciprocal Teaching Have students read *Reproduction in Gymnosperms* with a partner. One partner reads a paragraph out loud. Then, the other partner summarizes the paragraph's contents and explains the main concepts. The partners continue to switch roles with each new paragraph.

Use Visuals: Figure 11

L2

Life Cycle of a Gymnosperm

Focus Encourage students to study the photographs of the male and female cones in Figure 11.

Teach Ask: How is pollen transferred from the male to the female cone? (*Wind*) Why are male cones at the tips of branches rather than closer to the trunk? (*Branch tips allow more efficient pollen distribution.*)

What happens to male cones after they shed their pollen? (*They fall from the tree.*) What happens to female cones after fertilization? (*They stay on the tree as the seed matures.*)

Apply Ask: How does the shape of the seed affect its motion in the wind? (*The shape of the seed allows the wind to carry the seed some distance away from the parent tree.*) **learning modality: logical/mathematical**

Differentiated Instruction

Less Proficient Readers

L1

Understanding Reproduction in Gymnosperms Provide students with the section on Student Edition on Audio CD and a copy of the passage *Reproduction in Gymnosperms*. Have them listen to this passage as they read along and highlight key phrases and sentences that explain the

sequence of events in pollination, fertilization, seed development, and dispersal. Then pair students with more proficient readers. Have them construct a flowchart in their own words with the steps in the life cycle of gymnosperms **learning modality: verbal**

Monitor Progress

L2

Writing Have students use the following words in paragraphs to describe gymnosperm reproduction: *ovule, pollen, male, female, fertilization, seed, and scales*.

Answers

Figure 11 On the female cones



Pollen contains cells that mature into sperm cells. It is produced in male cones.

Gymnosperms in Everyday Life

Teach Key Concepts

L2

Useful Gymnosperms

Focus Tell students that the U.S. is the world's leading producer and consumer of forest products.

Teach Ask: **What useful products come from conifers?** (*Paper, lumber, rayon fiber, cellophane, and turpentine*)

Apply Ask: **How are managed forests renewable resources?** (*New trees are planted to replace trees that are cut down.*) **learning modality: verbal**



FIGURE 12
Uses of Gymnosperms
Conifers provided the lumber for this new house.

Gymnosperms in Everyday Life

Gymnosperms, especially conifers, provide many useful products. **Paper and other products, such as the lumber used to build homes, come from conifers.** The rayon fibers in clothes as well as the cellophane wrappers on some food products also come from conifers. Other products, such as turpentine and the rosin used by baseball pitchers, gymnasts, and musicians, are made from the sap produced by some conifers.

Because conifers are so useful to humans, they are grown in large, managed forests in many regions of the United States. When adult trees in managed forests are cut down, young trees are planted to replace them. Since different parts of the forest are usually cut at different times, there are always adult trees that can be harvested. These management efforts help ensure a steady supply of these important trees.



What are two products made from the sap of conifers?

Monitor Progress

L2

Answer



Turpentine and rosin

Section 2 Assessment



Target Reading Skill Previewing Visuals

Refer to your questions and answers about Figure 11 to answer Question 2.

Reviewing Key Concepts

- a. Listing** What characteristics do all gymnosperms share? What other characteristics do many gymnosperms have?
 - b. Comparing and Contrasting** In what way do gymnosperm seeds differ from corn or bean seeds, which are not gymnosperms?
 - c. Predicting** Do you think that the seeds of gymnosperms would likely be dispersed by animals? Why or why not?
- a. Reviewing** What is a cone?
 - b. Comparing and Contrasting** What are the two different types of cones? What role does each cone play in gymnosperm reproduction?
 - c. Sequencing** Briefly describe the steps in the reproduction of a gymnosperm.

- a. Identifying** Name two important products that come from conifers.
- b. Making Judgments** Do you think that managed forests guarantee that there will be a steady supply of conifers? Why or why not?



At Home Activity

Everyday Gymnosperms Describe the characteristics of gymnosperms to a family member. Then, with that family member, make a list of things in your home that are made from gymnosperms. Also list the gymnosperms that grow where you live.



At Home Activity

Everyday Gymnosperms L1

As a class, review the characteristics of gymnosperms and compile a list of gymnosperms that grow in your area of the country. After students look in their homes for gymnosperm products such as furniture, cellophane, and turpentine, have them bring their lists to class for comparisons. Encourage students to highlight any unusual products or uses.

Assess

Reviewing Key Concepts

- a.** They produce unprotected seeds; many have needlelike or scalelike leaves and deep root systems. **b.** Gymnosperm seeds are not enclosed by a protective fruit. **c.** Not likely; the seeds aren't enclosed in fruits that animals are attracted to.
- a.** The reproductive structure of a gymnosperm **b.** Male cones produce pollen. Female cones have ovules in which eggs are produced. **c.** Pollen falls from a male cone onto a female cone. Fertilization occurs when a sperm cell and an egg cell join inside the ovule. The fertilized egg becomes the seed's embryo.
- a.** Paper and lumber **b.** Possible answer: No; demand could increase or bad weather could decrease the yield.

Reteach

L1

Provide students with a copy of Figure 11 with the labels blanked out. Ask students to fill in the labels, then discuss the life cycle of gymnosperms as a class.

All in One Teaching Resources

- [Section Summary: Gymnosperms](#)
- [Review and Reinforce: Gymnosperms](#)
- [Enrich: Gymnosperms](#)